innovative environmental solutions, inc.

MEMORANDUM

To: Sandra Snyder/INGAA

From: Innovative Environmental Solutions

Date: June 17, 2019

Re: Summary of 2014 CAPP Report Leak Control Efficiency Estimates

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Summary

On June 5, 2019, INGAA and EPA staff held a call to discuss the leak mitigation control efficiency from a 2014 Canadian Association of Petroleum Producers ("CAPP") study. The 2014 CAPP study report estimated pre-control leak emissions from oil and gas operations, as well as leak emissions after implementation of a leak mitigation best management practice (BMP). The BMP recommended conducting leak surveys either quarterly, annually or less frequently than annually, depending on the component type.

During the June 5 call, EPA inquired about the frequency that CAPP member companies conducted surveys on open ended lines (OELs); depending on their type of service, the BMP recommended annual or quarterly survey frequency. To better understand the frequency of these surveys, IES contacted the study author, Clearstone Engineering. Clearstone's understanding was that program participants likely conducted surveys on OELs annually or less frequently. Very few or no quarterly surveys were conducted on OELs.

Based on this input from Clearstone, IES calculated the leak control efficiency for different scenarios and these results are summarized in Table 1. Assuming an annual survey frequency for all components, the calculated control efficiency is 70 to 75%. This result is similar in magnitude to the 80% control efficiency that EPA assumed in the Subpart OOOOa Technical Support Document (TSD) for quarterly surveys, and much higher than the 40% control efficiency that EPA assumed in the TSD for annual surveys.

Review of Leak Control Efficiency Calculation from CAPP Reports

INGAA provided EPA with a PowerPoint presentation[1] in advance of the June 5, 2019 call. During this call, INGAA and EPA discussed the natural gas leak control efficiency results in the 2014 CAPP Report.[2] This report estimated an overall 75% reduction in fugitive equipment leak emissions at upstream oil and natural gas facilities[3] since implementing best management

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[1] *See* INGAA-EPA Follow-up Call on Subpart OOOOa Proposed Amendments, June 5, 2019.

[2] EPA-HQ-OAR-2010-0505-4826, "Update of Fugitive Equipment Leak Emission Factors," Canadian Association of Petroleum Producers, Feb. 2014.

[3] *Id.* ("examined facilities include those in both sweet and sour service, oil production facilities and natural gas facilities ranging from single-well batteries and compressor stations through to gas processing facilities.").

practices (2007 CAPP BMP)[4] for control of fugitive emissions based on directed inspection and maintenance (DI&M). The 2014 CAPP Report and the 2007 CAPP BMP were both prepared by Clearstone Engineering. During the June 5 call, INGAA and EPA discussed the need to better understand the survey frequency for OELs and how those frequencies may impact the overall control efficiency estimate for natural gas transmission and storage (T&S).

The 2007 CAPP BMP provides leak detection survey frequency guidance for various "leak-prone" equipment components:

- Annual surveys are recommended for control valves, block valves, emergency vents, pressure relief valves (PRVs), and OELs;
- Quarterly surveys are recommended for compressor seals and blowdown systems (note: compressor seals are *not* subject to the leak detection and repair (LDAR) provisions in Subpart OOOOa – e.g., rod packing is addressed via prescribed maintenance schedule);
- For other components that are less "leak-prone," such as flanges and connectors, annual or less frequent surveys are recommended.

Subsequent to the June 5 call, IES called Mr. David Picard, the President of Clearstone. Although the survey frequency for OELs was not clearly documented in the CAPP study report, Mr. Picard's understanding was that most companies hired third-parties to conduct *annual or less frequent surveys*. CAPP recommended that companies implement quarterly surveys of the most leak-prone components using company personnel, but his understanding was that few if any companies conducted quarterly surveys. Thus, it appears that the "post-BMP" leak survey results and associated emission factors (EFs) are based on oil and gas operations that implemented annual (or less frequent) leak surveys.

During the June 5 call, INGAA and EPA also discussed calculating control efficiencies based on the 2014 CAPP report. By way of follow-up to that discussion, Attachment A includes: (1) Table 10 from the 2014 CAPP Report, which summarizes oil and gas section component EFs before and after BMP implementation; and (2) calculations of leak control efficiency from BMP implementation for different sectors, components, and making various assumptions about the frequency of surveys. These calculations are summarized in Table 1.

Given that INGAA represents interstate natural gas pipelines, INGAA is focused solely on the EFs for typical components in T&S service (i.e., gas compression). As noted above, LDAR for T&S excludes rod packing (i.e., "compressor seals"). Based on Clearstone's input that OELs were likely surveyed annually (or less frequently) and using typical components for the T&S sector, case 3 in Table 1 is likely the most representative example for T&S.

Case 4 and case 5 assume a percentage of OELs were surveyed more frequently than annual. Although this assumption is not consistent with Clearstone's understanding of the implementation of the BMP, IES provided these results purely for comparison purposes.

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[4] "Management of Fugitive Emissions at Upstream Oil and Gas Facilities," Canadian Association of Petroleum Producers, Jan. 2007, *available at* https://www.capp.ca/publications-and-statistics/publications/116116.

Table 1. Summary Leak Control Efficiencies from CAPP BMP Implementation and Annual Leak Surveys

Case / Components		Leak Emissions (kg/hr)		Leak Control Efficiency
		Pre-BMP	Post-BMP	
1	Oil and natural gas sectors, all components	1,242.0	305.5	75%
2	Natural gas sector only, all components except compressor seals[A]	750.9	221.7	70%
3	Natural gas sector only, all components except light liquid (LL) and compressor seals[A]	701.2	209.8	70%
4	Natural gas sector only, all components except light liquid (LL), compressor seals[A], and 20% of OELs[B]	606.7	200.3	67%
5	Natural gas sector only, all components except light liquid (LL), compressor seals[A], and 40% of OELs[C]	512.2	190.9	63%

A. Compressor seals are *not* LDAR components in Subpart OOOOa – e.g., rod packing is addressed via prescribed maintenance schedule.

B. Calculation assumes that 20% of the OELs are associated with compressor blowdown systems (e.g., Table 10 of the 2014 CAPP Report lists 424 compressor seals and 1,012 OELs; assumes an average of 2 seals per compressor and that every compressor has a blowdown system OEL that is surveyed quarterly for leaks).

C. Calculation assumes that 40% of the OELs are associated with compressor blowdown systems (e.g., Table 10 of the 2014 CAPP Report lists 424 compressor seals and 1,012 OELs; assumes an average of 1 seal per compressor and that every compressor has a blowdown system OEL that is surveyed quarterly for leaks).

Key observations from these calculations include:

- Case 1 data replicate the overall 75% control efficiency listed in the 2014 CAPP Report;
- Case 2 and case 3 are for the natural gas sector components and show a 70% control efficiency, both with and without inclusion of the light liquid components. Case 3 is likely the "best available information" for leak control efficiency from annual surveys for the natural gas sector and transmission and storage components; and
- The largest emissions reductions from BMP implementation were for OELs. Cases 4 and 5 provide results using alternative assumptions regarding the frequency of OEL leak surveys. As noted above, Clearstone's understanding was that few, if any, companies conducted quarterly surveys. These cases are shown in Table 1 purely for comparison purposes to demonstrate the impact of OELs on the overall results. The assumptions used in these cases are not consistent with best available information regarding how the leak control program was conducted.

As these cases in Table 1 show, the calculated control efficiency for T&S based on the CAPP study results is 70 to 75%, which is similar in magnitude to the 80% control efficiency EPA assumed in the Subpart OOOOa TSD for *quarterly* surveys, and much higher than the 40% control efficiency EPA assumed in the TSD for *annual* surveys. Since Subpart OOOOa includes a lower leak threshold (e.g., 500 ppm versus 10,000 ppm) and is a mandatory program, it is reasonable to anticipate that marginally lower emissions (and a marginally higher reduction efficiency) may be achieved with annual surveys – i.e., 75 to 80% control efficiency.

Attachment A

CAPP 2014 Table 10. Final consolidated emission factors for application in estimating fugitive emissions from upstream oil and gas facilities after the implementation of a formal DI&M program.

							Post-2007 Consolidated Results			CAPP (2005)			
Sector	Sweet/ Sour	Component Type	Service	Leaker Count	Component Count	Leak Frequency	EF (kg/hr/ source	95% Lower CI	95% Upper CI	EF (kg/hr/ source	95% Lower CI	95% Upper CI	Ratio
Gas	All	Compressor Seals	GV	79	424	18.63%	0.04669	40.98%	43.50%	0.71300	36%	36%	0.065
Gas	All	Connector	GV	534	170,148	0.31%	0.00082	36.22%	250.08%	0.00082	32%	32%	1.000
Gas	All	Connector	LL	10	25,203	0.04%	0.00016	53.81%	377.53%	0.00055	90%	111%	0.291
Gas	All	Control Valve	GV	31	61	50.82%	0.03992	43.70%	43.72%	0.01620	23%	23%	2.464
Gas	All	Open-ended line	All	40	1,012	3.95%	0.04663	41.85%	45.18%	0.46700	62%	161%	0.100
Gas	All	PRV	All	3	938	0.32%	0.00019	54.60%	420.36%	0.01700	98%	98%	0.011
Gas	All	Pump Seal	All	3	309	0.97%	0.00291	50.01%	366.79%	0.02320	74%	136%	0.125
Gas	All	Regulator	All	48	158	30.38%	0.03844	44.83%	44.86%	0.00811	72%	238%	4.740
Gas	All	Valve	GV	172	25,227	0.68%	0.00057	37.63%	163.49%	0.00281	15%	15%	0.203
Gas	All	Valve	LL	11	8,138	0.14%	0.00086	54.80%	441.88%	0.00352	19%	19%	0.244
Oil	All	Compressor Seals	GV	3	48	6.25%	0.01474	59.93%	66.05%	0.80500	36%	36%	0.018
Oil	All	Connector	GV	85	29,834	0.28%	0.00057	27.05%	96.39%	0.00246	15%	15%	0.232
Oil	All	Connector	LL	0	7,305	0.00%	0.00013	36.49%	281.62%	0.00019	90%	111%	0.684
Oil	All	Control Valve	GV	2	3	66.67%	0.09063	86.67%	86.67%	0.01460	21%	21%	6.208
Oil	All	Open-ended line	All	8	188	4.26%	0.15692	46.64%	46.74%	0.30800	78%	129%	0.509
Oil	All	PRV	All	0	212	0.00%	0.00019	37.71%	313.14%	0.01630	80%	80%	0.012
Oil	All	Pump Seal	All	0	130	0.00%	0.00230	38.39%	294.44%	0.02320	74%	136%	0.099
Oil	All	Regulator	All	12	14	85.71%	0.52829	38.03%	38.01%	0.00668	72%	238%	79.085
Oil	All	Valve	GV	14	5,297	0.26%	0.00122	44.15%	48.07%	0.00151	79%	79%	0.808
Oil	All	Valve	LL	0	2,381	0.00%	0.00058	36.94%	288.37%	0.00121	19%	19%	0.479
TOTAL				**1,055**	**277,030**	**0.38%**							

	G=B*D	H=B*E	G=B*D	H=B*E	G=B*D	H=B*E	G=B*D	H=B*E	G=B*D	H=B*E
	All Data		Gas Sector Only		Gas Sector Only		Gas Sector Only		Gas Sector Only	
			Zero Compressor Seals		Zero Compressor Seals & Zero LL Components		Zero Compressor Seals, Zero LL Components, 20% of OELS are Quarterly		Zero Compressor Seals, Zero LL Components, 40% of OELS are Quarterly	
	Post 2007 (Post-BMP) (kr/hr)	CAPP 2005 (Pre-BMP) (kg/hr)	Post 2007 (Post-BMP) (kr/hr)	CAPP 2005 (Pre-BMP) (kg/hr)	Post 2007 (Post-BMP) (kr/hr)	CAPP 2005 (Pre-BMP) (kg/hr)	Post 2007 (Post-BMP) (kr/hr)	CAPP 2005 (Pre-BMP) (kg/hr)	Post 2007 (Post-BMP) (kr/hr)	CAPP 2005 (Pre-BMP) (kg/hr)
	19.79656	302.312								
	139.52136	139.52136	139.52136	139.52136	139.52136	139.52136	139.52136	139.52136	139.52136	139.52136
	4.03248	13.86165	4.03248	13.86165					0	0
	2.43512	0.9882	2.43512	0.9882	2.43512	0.9882	2.43512	0.9882	2.43512	0.9882
	47.18956	472.604	47.18956	472.604	47.18956	472.604	37.751648	378.0832	28.313736	283.5624
	0.17822	15.946	0.17822	15.946	0.17822	15.946	0.17822	15.946	0.17822	15.946
	0.89919	7.1688	0.89919	7.1688			0	0	0	0
	6.07352	1.28138	6.07352	1.28138	6.07352	1.28138	6.07352	1.28138	6.07352	1.28138
	14.37939	70.88787	14.37939	70.88787	14.37939	70.88787	14.37939	70.88787	14.37939	70.88787
	6.99868	28.64576	6.99868	28.64576					0	0
	0.70752	38.64								
	17.00538	73.39164								
	0.94965	1.38795								
	0.27189	0.0438								
	29.50096	57.904								
	0.04028	3.4556								
	0.299	3.016								
	7.39606	0.09352								
	6.46234	7.99847								
	1.38098	2.88101								
TOTAL	**305.5**	**1,242.0**	**221.7**	**750.9**	**209.8**	**701.2**	**200.3**	**606.7**	**190.9**	**512.2**
Control Efficiency	75.4%		70.5%		70.1%		67.0%		62.7%	